TELRIC studies. Any allocation methodology should ensure that the sum of common costs allocated to various elements does not exceed Verizon VA's total common costs.[6] The method utilized by Verizon VA, in which common costs generally are calculated using an ACF so that such costs in effect "follow" the costs related to each element, is consistent with what has long been used by Verizon VA and recognized by regulatory bodies as reasonable. The specifics of Verizon VA's approach to calculating ACFs to identify and recover common costs are discussed in greater detail below.

## E. AVOIDANCE OF DOUBLE RECOVERY

**Q. How do Verizon VA's studies avoid double recovery?**

A. Verizon VA's general approach is designed to avoid the double recovery of costs. Thus, in determining the investment associated with a particular element, Verizon VA first identified the discrete separate assets dedicated to providing that element and calculated the investment associated with those assets. The ability to assign particular investments unambiguously to particular elements in this manner is a key factor in avoiding double recovery

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[6] *See* 47 C.F.R. § 51.505(c)(2)(ii) ("The sum of the allocation of forward-looking common costs for all elements and services shall equal the total forward-looking common costs, exclusive of retail costs, attributable to operating the incumbent LEC's total network, so as to provide all the elements and services offered").

under TELRIC approaches.[7] However, some assets are necessarily used by more than one element (*e.g.*, sharing of structure between loops and transport, sharing of building and power assets among elements located in the central office). In these cases, Verizon VA used explicit allocation methodologies to identify and apportion the total amount of the relevant shared investments among the different elements to prevent double recovery of those costs.

Similarly, Verizon VA's approach to the estimation of expenses, which depends on the application of ACFs, is designed to recover no more than the total forward-looking wholesale expense in element rates.

**Q. How does Verizon VA ensure that there is no double recovery of non-recurring costs?**

A. As explained more fully below and in the section of this testimony that addresses non-recurring costs, Verizon VA adjusts the Wholesale Marketing and Network ACFs (discussed below) to exclude non-recurring revenues, thus ensuring that these ACFs do not reflect the non-recurring expenses that Verizon VA seeks to recover through non-recurring rates.

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7 *See Local Competition Order*, 15845-46 ¶ 678.

Network Plant Description

## III. NETWORK PLANT DESCRIPTION

**Q: What are the basic components of the network on which the cost studies were based?**

A. Verizon VA's network is composed of a complex array of technologies and systems that inter-operate to provide telecommunications services. The network is best understood when the plant is subdivided into its major functional components:

(1) local loop facilities,

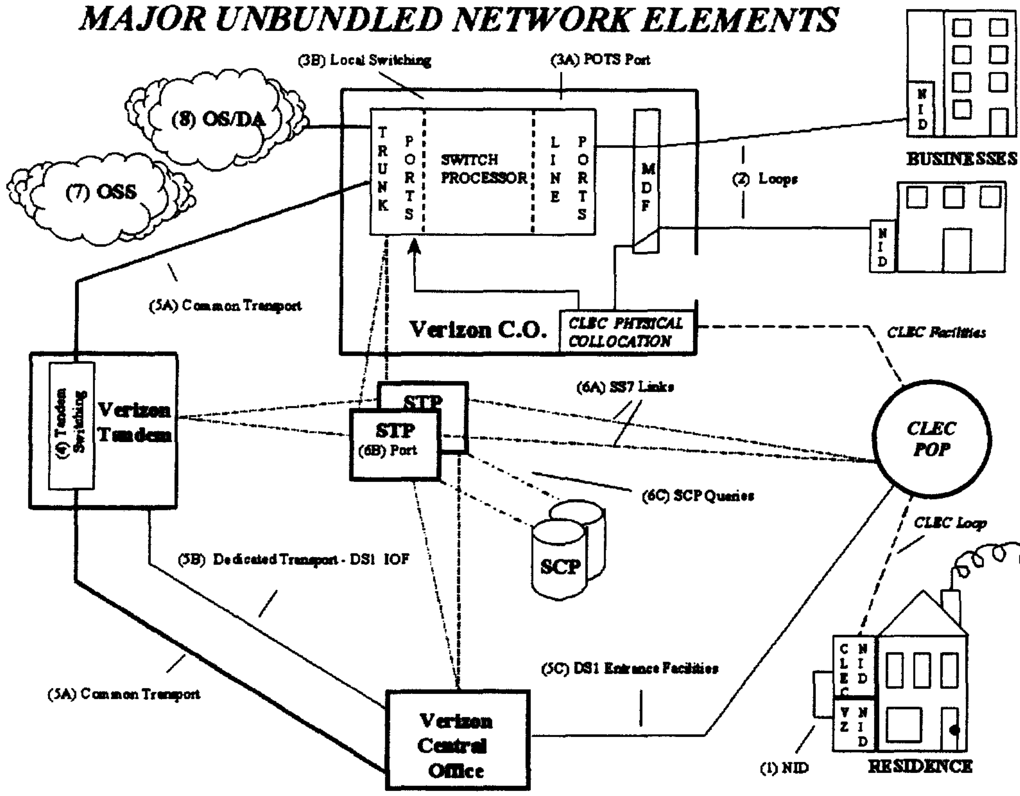
(2) local switching facilities, and

(3) interconnection facilities that interconnect Verizon VA's wire centers with each other and with the networks of other carriers.

The diagram below in Figure 1 depicts the overall architecture of the voice telephony network.

**Figure 1**

***MAJOR UNBUNDLED NETWORK ELEMENTS***




While the specific technological assumptions that Verizon makes for its studies are addressed in detail in the testimony concerning each UNE, the following discussion provides a general description of the network components and technology used in the Verizon VA network and assumed for purposes of the studies. As explained above, in all cases, Verizon VA has assumed rational deployment of the most efficient technology existing in its network today, taking into account the location of existing wire centers. Accordingly, the cost studies assumed that the forward-looking network would include the following:

**Digital switching.** Digital switching is the most efficient available technology for providing both local and tandem switching functions in a circuit-switched telephone network. Both incumbent LECs and competitive service providers employ these systems across the entire industry.

**DS0 channelization in IOF transport systems.** Because digital switches operate on DS0 channels, digital transmission systems with inherent DS0 channelization are naturally the most efficient options for transport between these switches. High-capacity fiber optic systems employing the SONET digital channelizing and multiplexing hierarchy are standard throughout the industry. These systems provide cost-effective direct digital interfaces that deliver DS0 channels to digital trunk switch ports. All the transport elements considered in the studies are built with SONET technology.

**Loop Facilities.** Local loops connect end user subscribers to the digital switches in Verizon VA central offices. These digital switches require delivery of signals to the switching matrix in a digital DS0 format. Because ordinary telephone sets create an analog electrical signal at the customer end of a basic access loop, the signal must be converted into a digital DS0 format for switching. This analog-to-digital conversion may take place anywhere along the loop path, including at an analog line termination port located at the digital switch. An integrated digital loop carrier system (IDLC) — in many cases, the most efficient currently available technology for terminating local loops on a digital switch — provides this conversion function in a remote terminal (RT) located at a point outside of the central office (*i.e.*, in the outside plant). This allows hundreds of analog lines to be converted into DS0 line signals and delivered over fiber optic cable directly to digital line switch ports at the central office.

However, IDLC is not at all cost-effective for delivering loops that must be unbundled on an individual basis (*e.g.*, when a CLEC provides its own switching facilities and needs only the facilities connecting the end user to the central office, or in the case of loops needed for private line services). Where a CLEC requires access to unbundled local loops or where customers require private line services, DLC in a "universal" configuration (UDLC) or all-copper facilities are the most efficient technologies for terminating local loops at the central office. In a UDLC configuration, the RT converts the analog signal to a digital signal, but at the central office, the signal passes through a channel bank in a central office terminal (COT) before continuing to the switch. The channel bank performs a digital-to-analog conversion and places each signal on a separate copper pair for delivery to the switch or to a CLEC collocation facility. In some cases (*e.g.*, where serving customers in lower-density locations close to the central office), an all copper loop, rather than a DLC configuration, is the most efficient technology.

Verizon VA has taken these factors into account and developed its cost studies using appropriate forward-looking assumptions regarding the most efficient combination of copper loops, IDLC, and UDLC in Verizon VA's network.[8]

**Signaling System 7 (SS7).** Digital switches in the circuit-switched network are controlled by software-driven processors. These processors interpret customer-dialing information and create the proper connections between lines and trunks in order to establish the desired call path. When more than one switch is involved in a call, those switches must exchange control information between them in a process called "signaling." In modern telecommunications networks, a technology called SS7 is employed to provide these functions. All of the signaling and control elements for which Verizon VA has developed costs are built using SS7 technology and related Advanced Intelligent Network Database Systems.

**Central office configuration.** The service area of an incumbent LEC (ILEC) such as Verizon is divided into areas called "wire centers." The physical geography and the number of customers covered by wire centers can vary widely. In a dense urban area, a wire center may be a few square miles and serve 100,000 or more customer lines. Rural wire centers might cover tens of square miles and might serve only several thousand customers or

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[8] These assumptions differ in certain respects for the recurring and non-recurring studies given the purpose of, and the types of costs sought to be recovered by, each.

fewer. Many factors have influenced the selection of the existing wire center boundaries, including political jurisdictions, topography, and engineering economy. The forward-looking network assumed in Verizon VA's studies is based on the existing wire center topography.

**Outside plant construction types.** Fiber and copper cables provide the loop access facilities from the central office (CO) to the customer, and similar fiber optic cables provide the interoffice transport facilities between COs. The studies assume the most efficient forward-looking mix of copper and fiber cables in the network.

Three major types of physical construction are used for these cables: underground, buried and aerial. A significant portion of the feeder and interoffice cable is typically routed underground through pre-constructed structures called conduit systems. In urban environments, distribution cable may be placed in conduit as well. Conduit systems typically consists of arrays of plastic tubes called ducts, usually four inches in inside diameter. Conduit arrays include underground chambers commonly called "manholes" that are used to house cable splices and some transmission equipment and to facilitate branching in the underground cable run. Conduit systems are most often constructed along or under major roadways.

Some cable is directly buried in trenches. Special armored cable must be used in buried applications, increasing the relative material cost of the system. The cost of buried installation is highly dependent on the terrain, soil characteristics, and availability of rights-of-way for the trenching.

The third method is aerial installation, in which cable is deployed by Verizon VA on poles and along or within buildings. This method is used to support distribution cable as well as feeder and IOF cable. Several pole sizes are employed, depending on the location and size of cables that must be supported. Large street-side poles are often shared with the power company and/or cable television company. Small backyard poles are widely deployed in urban residential neighborhoods along the boundary of rear adjoining lots.

Recurring Cost Study
Methodology

## IV. METHODOLOGY FOR RECURRING COST STUDIES (JDPL Issues II-1 to II-1-c; II-2 to II-2-c)

**Q. What does this section of the testimony address?**

A. This section of the testimony addresses the basic methodology that Verizon VA used to calculate costs in its recurring cost studies. Verizon VA's costing tools are described briefly, after which the methodology is explained.

### A. OVERVIEW

**Q. Please provide an overview of Verizon VA's basic methodology for calculating recurring UNE costs.**

A. As explained above in the Introduction and Executive Summary, to determine recurring UNE costs, Verizon VA generally began by identifying the relevant material-only in a forward-looking network design ("material-only investment") and dividing that by the total available units of capacity for that asset to arrive at a material-only investment per available unit. Verizon VA then applied a utilization factor to the per-unit material-only investment to develop the material investment per unit in service.

Verizon VA applied investment loading factors, where appropriate, to identify the total installed cost of an asset: these loading factors (discussed in detail below), account for things such as the costs of engineering, furnishing, and installing the equipment or facilities, the costs of the land and buildings used to house the equipment or facilities, and the power equipment necessary to run the installed equipment or facilities. The application of these loading factors produces a total cost installed (TCI) for the particular facility or equipment in question.

After calculating the TCI of equipment or facilities, Verizon VA calculated the associated forward-looking costs. Forward-looking costs were estimated through the use of three types of annual cost factors (ACFs), which are ratios that represent the relationship between a type of cost and either (1) the associated plant account investment, (2) relevant expenses, or (3) total revenues. The first type of ACF provides a calculation of costs (such as equipment maintenance and repair expenses or equipment capital costs) that are correlated with the level of investment in the equipment or facilities. The second type of ACF provides an estimate of common overhead costs (such as human resources expenses) that are correlated with associated Verizon VA expenses. The third type of ACF provides an estimate of certain expenses (*i.e.*, uncollectibles and regulatory assessments) that are related to gross revenues. Application of the ACFs, with certain adjustments that are discussed in detail below, produce an estimate of forward-looking costs.

The resulting total costs produce Verizon VA's total annual recurring cost for each network element. Verizon VA then either divided this total annual cost by 12 to establish a monthly recurring UNE rate or, in some cases, divided by the average number of minutes of use for the facility to derive a cost per minute of use.

**B. COSTING TOOLS**

**Q. Please identify models used by Verizon to develop its UNE costs.**

A. Verizon VA's recurring cost studies are based on Verizon VA's loop cost model (LCAM) and interoffice transport model. Verizon VA also utilized two models developed by Telcordia Technologies (formerly known as Bellcore): the Switching Cost Information System (SCIS), and the Common Channel Signaling Cost Information System (CCSCIS). Verizon developed a non-recurring cost model (NRC model) to calculate its non-recurring costs. The Cost Manual contains a description of these and other costing tools relied on by Verizon VA. See Attachment B.

**Q. Are there other tools used by Verizon VA to develop its cost studies?**

A. Yes. Verizon has developed a system called VCost, which is an integrated decision support spreadsheet building tool designed to develop consistent, high-quality cost studies in a standard environment with reduced cycle times. VCost facilitates the development of new studies and study updates under differing scenarios, and enables and enhances the analysis of studies across products, jurisdictions, and time. The system performs functions such as levelization and inflation in a standard format, thereby promoting consistency and accuracy. VCost also contains a repository of commonly used current data. VCost will enable the parties to assess the impact of modifying various study variables. VCost is described further in the Cost Manual, Attachment B.

**Q. How is VCost used to develop the recurring costs that are presented in this filing?**

A. As explained more fully in the following section, the general approach to developing the recurring costs in this filing is: (1) determine the investment associated with a given element or service; (2) apply the appropriate loadings to calculate the TCI for the investment; and (3) calculate the appropriate capital costs and operating expenses associated with the investment. VCost computes the capital costs based on the plant account of the investment, using inputs such as asset life, future net salvage, tax life, debt ratio, cost of debt, cost of equity, and state and federal tax rates. It is used directly or indirectly in the development of all cost studies presented in this filing.

## C. DETERMINATION OF INVESTMENTS

**Q. In general, how does Verizon VA calculate the level of investment for a network element?**

A. The first step in calculating the level of investment for a network element is to identify the relevant material-only investment for the equipment or facilities comprising the element. This is divided by the total units of available capacity for that element to arrive at a per-unit material-only investment, which is then divided by utilization factors to develop materials-only investment per unit of the element in service.[9] Finally, investment "loadings" may be applied to determine the associated engineering, installation, power, and land and building costs associated with the material investment. Each of these steps is described below.

### 1. Material Investments

**Q. How did Verizon VA determine the relevant material investments?**

A. Verizon VA used several different sources. Investments for copper and fiber cable generally were determined from Verizon VA's Vintage Retirement Unit Cost (VRUC) system (discussed further below). Switching materials investments were obtained from standard models developed by Telcordia, as described in more detail in the switching section of this testimony below. The levels of other investments were determined from Verizon reports or from Verizon VA's vendors.

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[9] *See Local Competition Order*, 15847-48 ¶ 682 ("Per-unit costs shall be derived from total costs using reasonably accurate 'fill factors' . . .; that is, the per-unit costs associated with a particular element must be derived by dividing the total cost associated with the element by a reasonable projection of the actual total usage of the element"). *See also* 47 C.F.R. § 51.511.

### 2. Utilization Factors

**Q. What is a utilization factor?**

A. The utilization of a particular facility is an "estimate of the proportion of [the] facility that will be 'filled' with network usage,"[10] and the utilization factor (sometimes called a "fill factor") compares the amount of the facility that is "filled" to the total capacity of the facility. Estimating utilization in this manner is not unique to telecommunications; it is much like comparing the number of occupied versus available seats on an airplane route to determine (1) when and whether it might be appropriate to use a larger plane or add another flight on that route, and (2) what rates to charge for the filled seats on that flight in order to fully recover the costs. Utilization has an impact on UNE costs, because the total cost of a facility must be allocated over those units of service (*e.g.*, subscribers, access lines, or minutes of use) that are actually "delivered" by the facility in question and that thus are available to generate revenue. If costs were simply spread across all available units of capacity, rather than only the units in service, the costs of the facility would not be recovered fully. The smaller the number of units that are actually in service (*i.e.*, the lower the utilization — in our example,

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10 *Local Competition Order*, 15847-48 ¶ 682.

meaning the fewer passengers on the plane), the greater is the fraction of the cost of the facility that must be assigned to each filled unit.

**Q. Should a facility's utilization factor ever be 100%?**

A. No. First, engineering capacity planners include a mandatory operating margin of unused capacity, usually called the "administrative spare," to accommodate factors such as maintenance needs, internal network administrative needs, and unexpected demand peaks.

However, this highest theoretical utilization (represented by 100% less the administrative spare) does not determine the actual average utilization level experienced in an efficiently designed network.[11] A variety of factors make it impractical and inefficient to build a network that is sized to function even at the highest theoretical utilization. These factors include:

**Breakage.** The practical utilization level that can be achieved is affected by "breakage," which refers to the fact that many network components come in limited sets of capacity. Breakage is the difference between the developed engineering requirement for a facility and the actual

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[11] Utilization factors are averages across a class or category of facilities, meaning that some facilities in each category are more "full" of usage than others.

available sizes for that facility. Because the available units of capacity rarely conform to the specific amount required, breakage typically results in spare capacity or lower utilization. For example, copper feeder cable typically can be purchased only in specific multiples of 100 pairs. Thus, if it is necessary to install 110 copper pairs on a particular feeder route, the minimum amount of cable that could be installed to satisfy that demand — which is a 200-pair cable — would result in a spare capacity of 90 pairs (producing a 55% utilization factor).

**Customer Churn.** Customer outward/inward movement affects utilization. Much of this outward/inward movement yields no net gain in lines and is referred to as "churn." When a customer moves out of a location, it may take some period of time before a new customer moves into that same location. The time between disconnect and reconnect varies widely but will always result in some idle time that will lower effective utilization levels. Switch ports, loop feeder plant, loop distribution plant, and interoffice facilities are examples of network components significantly impacted by churn. Increasing levels of local competition are likely to increase customer churn and thus further reduce the average utilization of network capacity in the future.

**Demand growth.** New network capacity must be installed in anticipation of demand growth, because capacity cannot be installed in real time to meet developing demand growth. Network additions must be installed in efficient increments reflecting the technical characteristics of the system and the cost of the installation. If capacity is added in increments that are too small, it will be necessary to make subsequent additions too frequently. This leads to inefficiently high construction and other installation costs. On the other hand, installing an addition that is too large will mean that utilization will be unnecessarily low over the facility's life cycle, leaving inefficient, stranded capacity. Engineering judgment must be applied to determine appropriate augmentation intervals — and capacity amounts — for each type of network facility.

At any point in time, some network systems will have just had a capacity addition, while others will be approaching the highest theoretical utilization. Across the whole inventory of network systems, it is reasonable to expect that systems will be randomly distributed across this utilization continuum.

**Demand Fluctuations.** The measures of customer demand commonly used in the industry (access lines, CCS/MS, dial minutes) represent statistical averages for a universe of customers. Though these statistical averages may be relatively stable over time across a statewide network, the actual experience will vary widely in smaller portions of the network. For example, across the Verizon VA network the average number of lines in service per residential customer in 2000 was 1.18. In a smaller portion of the network such as at a serving area interface (SAI), the number of lines in service might fluctuate significantly for any number of reasons. A burglary in a particular residential neighborhood might lead to an immediate increase in the number of alarm systems requiring a second line in that neighborhood, or a group of families with young children might become a group of families with teenagers requiring additional lines for internet access or other purposes. The network must be sized to account for these unpredictable peaks in demand; otherwise, Verizon VA would risk unacceptable delays in completing some service orders for new or additional services or customers. Maintaining a margin of available facilities necessary to accommodate unexpected demand peaks efficiently reduces the average utilization of network capacity.

**Q. How were the utilization factors used in these cost studies determined?**

A. Because the forward-looking TELRIC network does not yet exist, the utilization factors, like every other aspect of the forward-looking network construct, must be estimated by starting with present experience. In most cases, based on the judgment of its engineers, Verizon VA determined that its forward-looking utilization levels should be the same as Verizon VA's current actual utilization levels. In certain cases, Verizon VA's engineers concluded that some adjustments to Verizon VA's current utilization levels were appropriate in determining forward-looking utilization levels. The utilization factors and the specific bases underlying them are discussed in the relevant sections below.

**Q. Why is it reasonable to use Verizon VA's actual experience in estimating utilization factors in a forward-looking network?**

A. In most cases, current utilization factors provide the only reasonable basis for estimating future utilization. Any approach that entirely disregards Verizon VA's concrete experience serving its Virginia customers using the same, currently available technology that is assumed in the forward-looking model would be entirely hypothetical as well as arbitrary. By and large, Verizon VA engineers do not expect utilization factors in the forward-looking network using Verizon VA's currently-available technology to differ markedly from current utilization rates. The factors that contribute to utilization, described above, are not likely to change in Virginia over time or as a result of technological developments. If anything, increased competition which only increases fluctuations in customer demand, would result in reduced utilization.

Moreover, as discussed in the separately filed testimony of Drs. Shelanski and Gordon, Verizon VA is subject to price cap regulation in Virginia, and accordingly has (and has had) no incentive to overbuild its network with inefficient levels of spare capacity. To the contrary, Verizon

VA has every incentive to build a network with levels of capacity that are efficient and cost-effective for serving its customers.

**3. Investment Loadings**

**Q. What are Investment Loading Factors?**

A. All of the investments used in Verizon VA's cost studies reflect the total cost installed (TCI) of the necessary facilities and equipment, including required support investment. Verizon VA uses investment loading factors to translate material-only prices for equipment or a facility into the TCI for that equipment or facility.

**Q. Which investment loading factors does Verizon VA use in the studies to calculate TCI for an investment?**

A. Verizon VA has calculated Engineer, Furnish & Install (EF&I), Land and Building (L&B), and Power factors for use with specific equipment accounts: the digital switching, digital circuit and originating/terminating plant accounts. The calculations for these factors can be found at VZ-VA CS, Vol. XII, part G-4.

***a) EF&I Factors***

**Q. What does the EF&I factor represent?**

A. The EF&I factor helps translate a material-only investment into an installed investment by factoring in the amounts associated with items such as vendor engineering, Verizon VA engineering, transportation, warehousing, vendor installation, Verizon VA installation, and acceptance testing. Separate EF&I factors are developed by Field Reporting Code (FRC) for the following classes of investment:

(1) Digital Circuit equipment (Subscriber Pair Gain — equipment at central office; Subscriber Pair Gain — equipment at customer's premises; and other),

(2) Digital Switch, and

(3) SONET Circuit and other terminal equipment — CPE.

**Q. Is an EF&I loading factor applied to all investments?**

A. No. Data concerning certain facility investments, such as most of the investments tracked in the VRUC database (described in greater detail below), already include installation and engineering costs. Thus, it was not necessary to apply an EF&I factor to those investments. Verizon VA designed VCost to identify which loading factors are applicable to a particular class of investment (determined by plant account) based on whether the available data for that plant account already includes the engineering, furnishing and installation costs with the investment amounts.

**Q. How did Verizon VA develop the EF&I factors?**

A. The factors are developed on the basis of the data contained within Verizon VA's Detailed Continuing Property Record (DCPR) database. Specifically, for each class of plant, the total installed investment for central office equipment (*e.g.* hardwired equipment and plug-in equipment) installed in calendar year 1998 was then divided by the sum of the material-only investments of the same equipment, also derived from DCPR. This yielded the final EF&I factor, which represents the relationship of installed investment to material-only investment for equipment in the future based on the most current relationships available.

**Q. If forward-looking investments differ from the most recently installed investment levels, would it be necessary to make any adjustments to make the EF&I factors forward-looking?**

A. Yes. Verizon VA does not expect that the costs to engineer and install a piece of equipment would change simply because the price of that equipment were decreased; there is no reason to believe that the amount of time required to engineer or install a given piece of equipment would change simply because the price of the equipment were reduced. Thus, if one were to assume significant decreases in the price of equipment purchased in the future, the ratio of installation costs to material-only investments would